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AVIATION
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The Loening Fighting Monoplane in the Clouds

VOLUME VIII
Number 1

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SPECIAL FEATURES

THE PARIS AERONAUTICAL SHOW
FOREIGN AERODYNAMICAL PROPELLER BALANCES
EFFECT OF WIND UPON STABILITY AND MANEUVERABILITY
SOME RECENT GERMAN AIRPLANES
FACTORS AFFECTING THE WARPING OF PLYWOOD

PUBLISHED SEMI-MONTHLY
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The Aerial Performance of the Year

CREW OF U. S. MARTIN "ROUND THE RIM FLYER"—Left to right: Colonel Hartz, Lieuts. L. A. Smith and E. E. Harmon, Sergeants John Harding, Jr., and Jeremiah Tobias

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AIR SHIPS

FEBRUARY 1, 1920

AVIATION AND AERONAUTICAL ENGINEERING

VOL. VIII. NO. 1

Member of the Audit Bureau of Circulations

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RECENT performances of airships serve to emphasize the peculiar adaptability of lighter-than-air craft for extended voyages. Thus the R-34 twice crossed the Atlantic with a crew of thirty men, one of the passages being made from East to West, that is, against strong head winds—a performance which no heavier-than-air craft has so far succeeded in achieving. In Germany a regular passenger service is being operated by Zeppelins between Berlin and the Swiss frontier and Stockholm, while a British syndicate is drawing up plans for the establishment of a passenger airship service between London, Brazil and the Argentine Republic.

All these activities point to a growing conviction that airships have a field of activity all their own, in which they will not conflict with the purposes of heavier-than-air craft. Indeed, it seems quite definitely established that the airship will have for its sphere of action long-distance voyages, of say over 1,000 miles non-stop.

Now, it is a well-known fact that the larger an airship, the more efficient it is both from the viewpoint of speed for a given weight per horsepower and from that of "loading efficiency" that is, the disposable load expressed in percentage of gross lift.

Close study of Zeppelin development during the last twenty years brings out this fact most strikingly. The first Zeppelin, built in 1900, had for a gross lift of 12 tons a loading efficiency of 9 per cent., whereas Germany's last war Zeppelin, built in 1918, had a loading efficiency of over 58 per cent. for a gross lift of 77 tons. Of course, improved construction methods and materials also influenced this notable rise of the loading efficiency, for in 1913 a 22-ton Zeppelin had a disposable load of 7½ tons, whereas, the *Bodensee*, which was launched last year and is also a 22-tonner, has a disposable load of 10 tons. It follows from all this that there is no more a theoretical limit to the possible growth of airships than there is to steamships—although there may be a distinct practical limit to such an indefinite increase in tonnage, this being determined by the cost of hangars and docks, respectively.

In the field of non-rigid construction America is not only second to no other country, but probably leads the world today in efficient design. In the construction of semi-rigids Italy holds uncontested leadership, while in rigid airship construction Germany is still a good many years ahead of the rest of the world, although Great Britain comes a fairly close second.

The main problems which confront the airship engineer in his quest for important increases in size may briefly be stated as follows: In a non-rigid the envelope is depended upon to resist the caving-in tendencies which are due to the pull of the suspension cables toward the car; this can be insured only by maintaining the gas in the envelope under a pressure higher than that of the surrounding atmosphere. At the same time the nose of the airship must withstand the dynamic pressure which is created by flight under power, which pressure very rapidly increases with the speed—and an increase of speed is directly dependent upon increased size, because of the greater weight of more powerful engines, larger fuel consumption, etc. However, with increased size, which necessarily means a greater radius of curvature lest the longitudinal bending moments be unduly increased, a higher gas pressure is required to counteract both kinds of deformation, hence a thicker fabric must be employed. Unfortunately the weight of fabric increases more rapidly than its strength, so that we have here a vicious circle from which it is difficult to escape.

It is then obvious that there must be a distinct limit, generally placed at about 500,000 cu. ft. capacity, to the increase in size of non-rigids without decrease in loading efficiency.

This is why Italian airship engineers have developed—and with a great measure of success, too—a semi-rigid type in which a strong metal keel, which is internally trussed to the envelope and runs from stem to stern, takes care of the nose compression and *partially* of the longitudinal bending moment too. That is to say, the deflating of one gas cell will not cause the airship to "break her back," although in the case of several gas cells doing this, particularly amidships, the result may be questioned. However this be, the Italian type of semi-rigid has the very distinct advantage of requiring a much lower gas pressure and lighter fabric than non-rigids, so that a considerable increase in size can be achieved without loss of efficiency. Several 20-ton semi-rigids have successfully operated in Italy, and a 30-tonner is now under construction for a pioneer flight from Rome to Brazil. As the latter is the largest semi-rigid ever built, its performance will be watched with considerable interest by airship engineers with a view to estimating the practical size limitation of semi-rigids.

Whether the semi-rigid will prove practical for the largest sizes is open to discussion. It seems that the rigid, owing to its system of dividing the gas-containing portion into numerous cells, and the permanency of its hull, which permits to dispense with any great internal gas pressure, will eventually prove the logical type for the very large sizes of the future.

The Paris Aeronautical Exposition

Through the courtesy of *The Aeroplane*, of London, we are enabled to give our readers the following illustrated description of the Paris Aeronautical Exposition. As many of the machines exhibited, such as the Farman Goliath, the Bréguet and Voisin bombers, etc., and most of the British airplanes are well known to our readers, their description has been omitted.

Bréguet

The Bréguet 18T Berline, destined for commercial passenger carrying, has seats for two pilots well back behind the wings, and in front between the wings a cabin seating six, to which one enters by a side door.

Ahead of the cabin is the engine and radiator—the former a Renault of 450 hp.

The wings have three bays on each side of the fuselage, and bracing is by faired twin cable throughout. The lift wires in the inner bay are absent, their functions being fulfilled by wires running from the base of the inner struts to the chassis—an arrangement first used in Bréguet war machines to render it safe for the rear gunner to fire ahead between the wings, but which seems unnecessary and undesirable in this case.

Gasoline and oil tanks, enclosed in large torpedo form casings, are carried about two-thirds of the way up the first row of interplane struts on each side.

The whole machine is built in the main of duralumin. The fuselage, wing spars, and interplane struts are made from tubes of this material.

The fuselage joints are all made with welded steel sockets pinned to the tubes.

The side entrance door which when open leaves an unbraced panel in one side of the fuselage is made to act as a bracing panel itself, and is provided at top and bottom with steel hooks which are rotated to engage firmly with a socket in the fuselage structure when the handle locking the door is closed.

The Bréguet 18T has a span, top and bottom, of 17.42 m. and an overall length of 10.10 m. The wing area is 73.5 sq.m., the weight empty 1,600 kg., and the weight loaded 2,700 kg. High speed is 170 km. p.h., the climb to 2,000 m. is 17 min. and the ceiling 5,200 m.

Type 14T is a seaplane which is very similar to the 18T and is fitted with a cabin for three.

The wings have but two bays instead of the three of the previously described machine, but in the inner bay on each side there is a pair of upper halves of Spad type, intermediate struts running from the intersection of landing and flying wires to the spars of the upper wings, and on these are mounted the fuel tanks. Whether this strut is merely provided for this purpose or whether it is an essential part of the wing structure is not known.

The float arrangement is one large central float supplemented by a pair of wing floats and a tail float.

The tail float, which is of triangular cross-section with a very sharp Vee bottom, is attached to an ordinary tail skid, and the fore end of the fuselage is equipped with a double set of sockets, one set being used with the float undercarriage and the other set serving for the reception of a wheeled undercarriage. Thus the machine is readily convertible to a land-going airplane.

The main float has a sharp bow and a square stern and has a beam nearly equal to its length. It is fitted with a Vee bottom forward, gradually washed out to flat at the step, which is roughly half way between bow and stern.

The dimensions of the 14T are similar to those of the 18T, but the span of the upper plane is only 14.36 m. and that of the lower is 12.40 m. The power plant is the same, a 450 hp. Renault, but the weight empty is only 1,280 kg. and the weight loaded 1,800 kg. High speed is 165 km.p.h., the climb to 2,000 m. is 18 min. and the ceiling 3,000 m.

De Marçay

Three airplanes were shown by Edmond de Marçay. One of these is, according to the claim of its constructor, the smallest airplane in the world, its span being 4 m. and its length 3.8 m. The fuselage is of the monocoque type and the tail plane and fin are also covered with plywood. The interplane struts are interesting in that they are only joined to the front spar in the upper plane, but embrace both spars of the lower plane. Thus the upper rear spar is left free for the warping of the wings, instead of the more usual aileron control. It is about the only serious airplane in the show with warping wings.

The next larger de Marçay machine, illustrated in the accompanying sketches, is a single-seater biplane of 5 m. span and 15 m. length, fitted with the new 60-hp. Le Rhône engine. The fuselage is the usual plywood monocoque and shows no novel feature.

The interplane struts are of the type used in one of the experimental Nieuports and in the Lepère biplane, that is to say, each pair of struts (fore and aft) is connected one to another top and bottom by fore and aft pieces of wood, so that the two struts and these two stretcher-bars, as one might call them, form a single unit, which is in the shape of a non-rectangular parallelogram in which the inside corners are rounded instead of being angular.

The third machine is very similar, but it is a two-seater. It has a span of 8 m. and a length of 5.5 m. The same type of 60-hp. Le Rhône engine is used.

These two machines have a very neat spinner on the airscrew, in which there is a hole in the nose, through which air is admitted to the crankshaft, through which this new Le Rhône draws air for the cooling of the crankcase.

Potez

The more interesting of the two Potez machines exhibited was a tiny biplane (the type VIII) with a Potez engine of 50 hp., which is stated to weigh 100 kg. and to consume 15 litres of gasoline per hour. The engine is a 4-cyl. (in line), air cooled, placed with its cylinder-heads in front and its shaft vertical. The shaft drives a bevel gear at its top end, the airscrew being attached to the second bevel wheel, so that the airscrew shaft is parallel with the axes of the cylinders and the screw itself revolves a few inches in front of the cylinder-heads. This gives a very high thrust-line and keeps the weight low. If the engine works properly the idea seems excellent, but as the engine has no flywheel one has doubts about the effects of the explosions on the gears and on the screw.

The machine itself is a neat biplane, with a single pair of duralumin struts on each side of the fuselage and an inverted Vee cabane to the center section. Ordinary cable bracing (single) is used. The ailerons, on the upper planes only, are worked by tubes and bell-cranks, the horizontal tube from the cockpit being carried inside the wing behind the rear spar.

The undercarriage has four wheels on which the machine rests permanently when on the ground. The small cane bows under the rudder are only an emergency fitting.

The whole skeleton of the machine—wings, fuselage and empennage—is of duralumin.

The Potez VIII has a span, upper, of 8 m. and lower of 6.8 m., while its length is 4.7 m. The wing area is 19 sq.m., the weight empty 220 kg., and the weight loaded 420 kg. The useful load comprises fuel for 3 hr. flight. The engine, illustrated in the accompanying photographs, has a bore of 100 mm. and a stroke of 120 mm., it turns at 2,200 r.p.m., while the propeller is geared down to turn at 1,100 r.p.m.

The other machine (type S.E.A. VII) is a series-built biplane, more or less of Bréguet type, built for war work, but now fitted with a very well arranged and finished two-seater limousine behind the pilot, somewhat in the manner initiated by the Airco.

Louis Clement

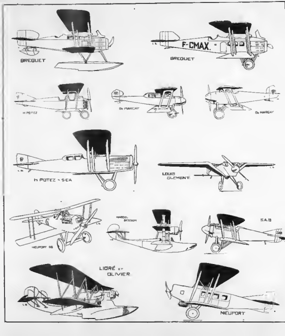
This firm, one of the earliest pioneers of all metal airplanes, exhibited two curious machines.

Of these the more extraordinary was a racing monoplane, fitted with 180 hp. Hispano-Suiza, cantilever wings, a folding chassis, and a retractable radiator.

The fuselage of this machine is built throughout of steel tubes, wire braced, and of small cross section.

The wings spring from the lower longerons, and at their roots have a great dihedral angle for a distance of roughly 1 m. when—having arrived at the level of the upper longeron

Some of the Exhibits at the Paris Aero Show



—they bend to the horizontal. From the point at which they bend a steel tube strut runs to the fuselage top longerons from each spar.

Apart from these struts the wings are entirely unbraced and all loads are taken by the wings' spars as cantilever beams. These spars are riveted up duralumin box girders, with a maximum depth at the angle between the horizontal and the sloping part of the wing, tapering thence both to the wing root and to the wing tip. At the maximum point the front spar is about 7 in. by 2 in. and appears to be of about 16 gauge thickness.

Very narrow ailerons are fitted to a false spar in the rear of the main spar.

The undercarriage consists of two Vees of half streamline tube, that is, flat on one surface, each Vee carrying one wheel on a rigid overhang stub axle. These Vees are each pivoted on a hinge carried on the lower longerons of the fuselage. The rear leg of each Vee has an extension welded on, projecting upwards into the fuselage, about 6 in. long, and between these two extensions there is provided a telescopic screwed strut—after the manner of a large wire strainer. There is no other connection between the two Vees, and thus this strut, in compression, is all that prevents the two halves of the undercarriage from spreading outwards. When this strut is closed—by rotating the part corresponding to the strainer body—the two Vees fold outward and finally lie on the surface of the inclined part of the wing, the wheel ensconcing itself in a large hole cut in the under surface of the wing.

The radiator is fitted in a vertical slide and may be pushed right out on the under side of the fuselage, or withdrawn to any desired extent within the fuselage.

A very small tail plane with elevators fitted on the lower side of the fuselage, and a still smaller rudder, are attached aft, and a tail skid, formed of a single piece of inclined streamlined tube, pivoted and sprung on Sandows, completes the machine.

There can be little doubt that the reduction of resistance has been very thoroughly attended to in this design, but great faith is required to believe that the undercarriage will remain in its intended place when getting off or landing. The machine has 18 sq. m. surface and is stated to weigh 670 kg. with full load.

The other machine shown was a little triplane, which has the air of having been an assiette to which an engine has been added.

The wings, of about 1 m. chord and 1 m. gap, are unstaggered, and the lower one is of somewhat reduced span. At each of its tips this wing carries a wheel of the bicycle type, sprung from within the wing itself.

On the bottom wing a fuselage, built of light steel tube and covered in fabric, provides accommodation for the pilot and carries at its forward extremity a third wheel and at its after end a tail plane elevator and rudder.

Behind the wings, above the fuselage, a Y Anzani engine of 35 hp. is mounted on a light tube cradle, and drives—by a long shaft encased in an aluminum tube—an airscrew, which is in front of the pilot's seat and is supported on a three-steel tube of ½ dia. and about 2 ft. length from the nose of the fuselage.

The wings are mounted on two pairs of center section struts, springing from the fuselage, and there is one interplane strut on each side, which spreads out to embrace both spars on the bottom wing, but which only supports the front spar of the two upper wings.

These wings are warped about this strut by wires to both leading and trailing edges. The machine has 13 sq. m. of surface, weighs 60 kg. empty, and is designed to carry 80 kg. of load—one pilot and a little fuel and oil.

Levasseur

M. Levasseur was famous before the war as a maker of airscrews, noticeable for their scimitar shape. Early in the war he became an airplane constructor and made various types of machines under contract in his excellently equipped factories. Latterly he was turning out Spads, and thus was brought into contact with M. Béchéreau, the famous designer of the Deperdussin monoplanes of 1911-1914, and later of the Spads.

In consequence, M. Béchéreau, who had left the Spad-Blériot firm, had his latest ideas embodied in a fighting biplane built by M. Levasseur. This machine, which was one of the most striking in the Show, was displayed on the Levasseur Stand.

The Béchéreau-Levasseur is a big single-seater with a monocoque body. It is known officially as the S.A.B.4, the initials standing for Société des Appareils (or des Aéroplanes, or des Avions) Béchéreau.

The most noticeable feature about it is the radiator, a new design of M. Béchéreau's, which forms a ring round the engine cowl and makes an excellent streamline shape of the front of the machine as it continues the line of the spinner and rounds off the whole front outside the limits of size of the engine (a 300 hp. Hispano-Suiza), thus covering the excrescences usually caused by the Suiza cylinder heads.

The machine is equipped with four machine guns, two in the cowl, as usual, and two in the upper plane, in which the cartridge belts are neatly stowed. To increase accuracy in shooting, the machine is designed without a cabane and without cross-bracing between the fuselage and the center section of the upper plane, so that the pilot has a perfectly clear view over the cowl.

This is achieved by arranging the inner pairs of interplane struts so that they slope inwards towards the middle of the upper plane, and by bringing a pair of struts on each side (under the lower plane) from the feet of these interplane struts to a point in the undercarriage behind the wheels. Thus the whole center of the machine is firmly braced and, as the struts are of sheet aluminium beaten to streamline shape, they serve equally for tension and compression members.

Another interesting idea in the machine is the balancing of the elevator and ailerons. Instead of making a projecting balancing piece at each end, the flaps have their leading edges made in a zig-zag shape. The hinges are fixed to the rearmost points of the zig-zag, and the result is that when the flaps are moved the foremost points of the zig-zag project above or below the wing or tail plane (as the case may be), and should give a very useful balance.

The S.A.B.4 has a span of 6 m., a length of 6 m., and a chord of 1.8 m. The maximum speed is 250 km.p.h.

Another exhibit of interest was a variable pitch airscrew. The firm claim to have overcome the great difficulty of keeping the wooden blades inside the steel tubes which hold them to the mechanism. This is done by building flat wedge-shaped—or rather barb-shaped—pieces of steel with projecting screwed ends into the laminations of the screw and holding the whole blade back against centrifugal force by these screws.

Besson

The Société des Constructions Aéronautiques et Navales Marcel Besson showed a very pretty little triplane two-seater flying-boat, fitted with the 6-cyl. 60 hp. Le Rhône engine. The hull, of the boat-built type, seats two side by side between the wings.

The lower wing springs from the hull, and from the junction of wings and hull rise four center-section tube struts, forming a pyramidal cabane, which carries both the middle pair of planes with the circular section streamline engine and fuel tank housing between them and the upper plane.

The lower wing tips are fitted with a pair of small floats.

A single plank strut on each side of the hull connects the spars of the three planes, which are braced with stranded cable for both flying and landing loads. Ailerons are fitted to the top and central wings only.

The tail consists of a fixed plane and elevators and a balanced rudder without a fin.

The span, equal on all planes, is about 6 m. and the chord is 1.1 m. The length overall is about 8 m., and the machine is expected to make 90 km.p.h. with two up and three hours' fuel.

Farman

The Farman exhibit included besides the well known Goliath, which was recently described in these columns, a small two-seater sport machine fitted with the new 60 hp. 6-cyl. Le Rhône engine, and designated—probably in contradistinction to the Goliath—David.

The fuselage is a rectangular section affair built on longerons and struts, covered with glued and nailed on three-ply. The engine is mounted in the usual way on the front end, with the pilot's seat just behind the engine—followed by a second seat very close up to the first.

The center section upper wing is supported on four rather lanky vertical struts.

The wings are heavily staggered and are mounted on one

pair of N struts on each side. Flying and landing wires are double 14G piano wire. Ailerons are fitted on upper wings alone.

Except the rudder, which has a curved upper extremity, all the surfaces are of the Farman cut-off-square type.

The Farman David has a span of 7.10 m., an overall length of 6.135 m., and weighs empty 260 kg., and loaded 400 kg. The high speed is 140 km.p.h. and the low speed 60 km.p.h.

Nieuport

The Nieuport exhibit was of more than ordinary interest, for it included the speed and altitude record-breaking machines.

The machine which, flown by Lieut. Casale, put the altitude record up to 9,545 m. is a type 29D. It is a small biplane, with two pairs of struts on each side of the fuselage. The engine is a 300 hp. Hispano-Suiza, fitted with two of the Lamblin radiators, now so popular in France, which look like a ship's fenders. The Lumière airscrew, which pulled the machine to this immense altitude, is on the machine. The upper plane is a single piece, resting on a short cabane. The lower plane has ailerons along its full span. On this machine the ailerons are balanced by a piece projecting beyond the ends of the plane.

The speed record-breaker of M. Sadi-Lecointe is similar to the altitude record-breaker so far as the fuselage is concerned, but has only a single pair of struts on each side of the fuselage. In this the engine is likewise a 300 hp. Suiza, but a single Lamblin radiator is fitted, with a small honeycomb radiator just in front of the engine. The airscrew, as usual, is a Lumière. The ailerons cover the whole length of the lower plane, but are not balanced.

This machine is illustrated in the accompanying sketches.

There was also shown a big passenger machine with a 450 hp. Renault engine—12 cylinders, 134 mm. by 180 mm., giving 470 hp. at 1,600 r.p.m. This is quite a useful looking craft, built on the usual sound Nieuport style. It has a huge cabin for six or eight people in the fuselage. The wings have a pronounced backward stagger, and have two pairs of struts on each side of the fuselage. Three Lamblin radiators are fitted under the engine. It is intended to run machines of this type alternately with the Airco machines on the London-Paris service.

The altitude record type, or 29D, has a span of 8.7 m., an overall length of 6.5 m., and a wings area of 27 sq. m. The weight empty is 761 kg., and the weight loaded 1,100 kg. Fuel is carried for 2½ hr. flight at a high speed of 236 km.p.h. The machine climbs 1,000 m. in 1 min. 56 sec., and 6,000 m. in 18 min. 46 sec. The ceiling is at 9,500 m.

The speed record type is somewhat smaller, its span being 6 m. and its overall length 6.20 m., while its wing area is 13 sq. m. The weight empty is 620 kg., and the weight loaded 834 kg. The fuel load permits a 1-hr. flight. The high speed is 307 km.p.h., or 190 m.p.h., which constitutes the present world's record.

The Nieuport Transport, or type 30T, has a span, upper, of 13.5 m., lower of 14.5 m., and a wing area of 55 sq. m. The weight empty is 1,500 kg., and the weight loaded 2,400 kg. The performance of this machine is not stated.

Lioré and Olivier

Upon the stand of Lioré et Olivier was to be seen a large flying boat, said to be destined for passenger and mail work in the Mediterranean.

The machine is of the triple-engined variety, with one 260 hp. Salmson 29 engine in the center and two 220 hp. Hispano-Suizas in nacelles between the wings.

The hull, which is entirely of wood with triple diagonal planking, is of very curious shape. Beginning with a sharp stem, it swells out rapidly to a form of very great beam and relatively small freeboard, upon which is erected a superstructure, much narrower than the hull proper, in two tiers.

The lower tier is an enclosed cabin with four seats, at the front end of which is applied the central engine mounting. In the second tier is the pilot's seat, set between front and rear spars of the upper plane, through a hole in which the pilot protrudes his head and enters and leaves his cockpit.

Aft of the cabin the superstructure hull narrows in to an oval monocoque form, which bends up at the rear to carry the tail surfaces.

The wings are unstaggered and have little or no dihedral, and the bracing is entirely of triangulated duralumin tubes of streamline section, carefully arranged so that those which are normally compression members shall be as long as possible, whilst the tension members are short. The wings themselves are entirely built of timber and are fitted with balanced ailerons.

Large streamline wing floats are fitted near the tip of each lower wing—also of diagonally planked timber construction. The two wing engines are carried midway up the interplane gap in aluminium nacelles, in the tail whereof are the main petrol and oil reservoirs for the whole machine. The central engine is fed from a gravity tank in the upper wing, supplied from either nacelle reservoir by wind-driven pumps.

The tail plane—carried on the upturned after part of the hull—is a monoplane, braced to the hull on each side by an N of duralumin tubes, fitted with divided balanced elevators. There is a large central balanced rudder, and near the tip of the tail plane there are a pair of fins, which may be set over by the pilot as a counter measure to the failure of either wing engine.

The hull is divided into nine water tight compartments.

The Lioré-Olivier seaplane has a wing area of 90 sq. m. and carries a useful load of four passengers and 300 kg. of mail, together with fuel for 5½ hr. flight at a full speed of 150 km.p.h., or for 8 hr. at a cruising speed of 130 km.p.h.

The Bleriot Mammouth

The Bleriot Mammouth, one of the largest multi-engine machines constructed in France, recently passed successful trial tests. The following description and accompanying diagrammatic sketch are taken from *La Nature*, of Paris. A front view of the center portion of this machine appeared on the cover of AVIATION AND AERONAUTICAL ENGINEERING for Nov. 15, 1916.

The Bleriot Mammouth is a four-engined tractor biplane of 1614 sq. ft. wing area and 1,200 hp., furnished by four Hispano-Suiza model H engines. The span is 89 ft., the weight, fully loaded, 17,600 lb., and the high speed 80 m.p.h. The machine has accommodations for twenty-one passengers exclusive of the crew and has a full speed endurance of 7 hr.

A high lift wing section, characterized by a very thick profile, is used and the planes are set at a pronounced negative stagger, partly to insure better lift and partly better vision. The struts have a large fineness ratio.

The fuselage, which is constructed of aluminum alloy and plywood, has two decks. The upper deck is fitted with five wicker chairs forward and twelve aft of the pilot compart-

DIAGRAMMATIC SKETCH OF THE BLÉRIOT MAMMOUTH

ment, which is raised above the deck so as to insure a wide sweep of the ground. The pilot compartment seats three, namely, the pilot, his assistant and a mechanic. On the lower deck, forward, a navigation room and a wireless cabin are fitted, the former contains the navigational instruments and has a window let into the floor for inspection of the ground. Aft of the radio cabin there is a baggage hold and a small cabin for four second class passengers.

The tail unit consists of biplane stabilizers and elevators and of three rudders. The control surfaces are balanced.

A trap door, which acts as a ladder when it is let down, permits access into the fuselage. The interior is heated by electric radiators and special attention has in a general way been paid to insure the comfort of the passengers.

New Fiat Airplane and Engine

Two new Fiat products were exhibited at the recent Paris Aeronautical Exposition. One of these is a development of the high speed long range bomber which Fiat produced near the end of the war and which has since been modified for commercial work, while the other is a radial water-cooled 9-cyl. airplane engine.

Fiat A.R.F. Airplane

This machine, which is officially known as model A. R. F., is a two-place tractor biplane equipped with the 12-cyl 700 hp Fiat engine. The span is 53 ft. 2 in., the overall length 33 ft. 3 in., and the overall height 12 ft. 2 in. The fuselage, which is of considerable height, seats pilot and passenger in tandem aft of the engine. In order to obtain high speed and great lifting capacity, the closest attention has been paid to the streamlining. It may be seen from Fig. I that even the exhaust pipes projecting on each side from the engine housing are encased in an aerofoil shaped fairing, which thus form a supplementary lifting surface, while the landing gear is also carefully streamlined.

The Fiat A. R. F. has a maximum horizontal speed of 160 m.p.h. and carries beside two persons and 440 lb. of useful load sufficient gasoline and oil for a continuous flight of 18 hr., which represents a distance of 2,730 Sta. mi. It had been intended to make a transatlantic flight with the original B.R.F., but this exploit having been accomplished while the machine was under construction, it was not considered worth while attempting.

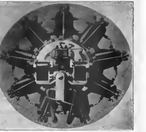
The weight of the machine under full load is about 10,200 lb., which is apportioned as follows: 5,070 lb. for the airplane, 4,000 lb. for gasoline, 660 lb. for oil, and 440 lb. for useful load. The latter can obviously be increased by reducing the amount of fuel carried and by decreasing the radius of action. This machine is probably the fastest plane of its load carrying capacity in existence. It is also the most high powered single engine airplane built up to date. It has been extensively used on long distance cross-country flights, from Italy to France, England, Belgium and other portions of Europe.

Fiat A-18 Engine

The Fiat Co. having specialized during the war on vertical and V type water cooled aviation engines, the production by this firm of a radial engine comes somewhat as a surprise.

This engine, designated as type A-18, is a 9-cyl. water-cooled radial and develops 300 hp. at 1,800 r.p.m. Its total weight empty is 500 lb., and with water 546 lb. The weight per horsepower is thus 1.6 lb. without water, and 1.9 lb. with water.

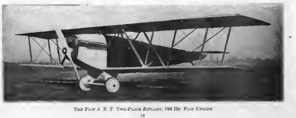
The nine cylinders are steel forgings with welded-on water jackets, and are mounted around a circular aluminium crankcase. The intake pipes are inside the water jackets, and consequently are heated by the water circulation system. There are four valves per cylinder mounted in the head and operated from a single plate cam and push rods. The crankshaft, which has a single throw, and is carried in ball bearings, receives the master connecting rod and the eight auxiliary rods, all of which are mounted in ball bearings. Ignition is assured by two high tension magnetos mounted on a platform on the rear face of the crankchamber. Each magneto fires nine plugs, which are mounted horizontally in the cylinders below the



FIAT A-18 300 HP WATER-COOLED 9-CYL. RADIAL ENGINE

valves, thus either magneto is capable of running the engine. On the same face of the crankchamber is the double piston-type oil pump, and immediately below it is the water pump. The single carburetor, with adjustment for high altitude flying, is also on this side of the engine. The mixture is taken through gas passages in the base chamber to the pipes inside the water jackets, and from there to the valves in the head.

The general neatness of the design is noteworthy.



THE FIAT A. R. F. TWO-PLACE BIPLANE, 700 HP FIAT ENGINE

Some Foreign Aerodynamic Propeller Balances

In a recent issue of *Engineering* (London) William Knight gives a detailed account of the aerodynamic balance used in the St. Cyr Aerodynamic Institute for testing model propellers, together with some interesting information of the Crocco balance used for the same purpose by the Instituto Centrale Aeronautico, at Rome. An excerpt from this article, with the original illustrations, is printed herewith.

Crocco Balance.—In the Crocco balance, which is schematically represented in Fig. I, a 3-h.p. variable speed D.C. motor,

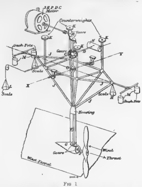


FIG 1

maximum speed 1,500 r.p.m., is supported on a framework structure right above the experimental chamber of the wind tunnel. The rotary motion of the motor axis is transmitted through two bevel gears to a vertical shaft A, the r.p.m. of A being double the number of r.p.m. of the motor axis. At the opposite end, shaft A is geared to two horizontal shafts C and D, and through them to a second vertical shaft placed on the same axis of shaft A—four equal gears link together the four shafts.

A third vertical shaft E placed in the same axis as the other two vertical shafts is connected to them through a cardan O, which allows a free oscillation of E and the frame structure J around the horizontal axis XY perpendicular to the axis of the tunnel and coinciding with the axis of oscillation of the cardan. At the free end, shaft E is geared to the propeller shaft F, the number of r.p.m. of the propeller being double the number of r.p.m. of the vertical shaft and four times the number of r.p.m. of the motor. The swinging arm E, and the gears G are all enclosed in a casing of a suitable shape such as to reduce to a minimum the turbulent motion of the air behind the propeller.

The resisting torque of the propeller reacts on the four gears linking together the vertical shafts with the two horizontal shafts C and D, which will have tendency to rotate in an horizontal plane around the vertical axis, and are prevented from doing so by adding weights at L. Opposite the free end of shaft D, by using a special clock-work arrangement, the number of r.p.m. of shaft A is recorded on a revolving drum. Knowing the weights added at L and the length of lever arm C, it is easy to calculate the resisting torque, which will be the resisting torque of the propeller plus the frictional resistance of the gears in the transmission.

The Italians make the necessary correction of the torque so measured by using a set of calibrating curves, giving the

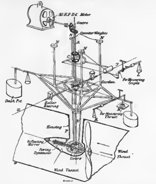


FIG 2

efficiency of the transmission in terms of the magnitude of the weights added at L and of the r.p.m. of shaft A. For small values of the weights added at L, the efficiency is very low. When the weight at L is in the order of magnitude of about 4 kg., the efficiency of the transmission is about the same at all speeds, and is equal to .92.

The fact that the torque measured at L included the resisting torque of the transmission gears was judged to be a disturbing factor, which it was desirable to eliminate in the St. Cyr balance, as it was likely to influence, in some cases, to a noticeable extent, the measure of the torque. In fact, if we were concerned with the measurement of large propeller torques only, the resisting torque of the transmission would probably be a small percentage of the total, and, by neglecting it, the error made would not be a large one. But, in the case of small propeller torques, the resisting torque of the transmission may be large enough to seriously affect the experimental results.

The method used by the Italians of multiplying the torque measured at L by a numerical factor called efficiency of the transmission (obtained by using in place of the propeller an electric brake of the Pasqualini type, made by Galileo Galilei, Florence, Italy), only corrects the error to a certain extent, because the resistance of the transmission depends on the lubrication of the gears and on the atmospheric temperature

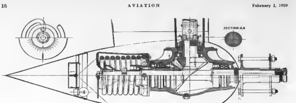


Fig 3

as affecting the viscosity of the lubricant, etc., which are not accounted for in the calibration curves.

The propeller thrust has the tendency to give rise to an oscillation of E, and the structure J rigidly connected to it

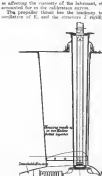


Fig 4

around the horizontal axis XY, and it is prevented from doing so by the addition of weights at H

Knowing the distance of H and the distance of the propeller shaft from the axis of rotation XY: (1 m. and 2 m., respectively), the actual value of the propeller thrust will be equal to one-half the weights added at H This does not include, of course, the air resistance of the casing containing the shaft E and the gears transmitting the rotation to the propeller, which must be added to the force measured at H before dividing by 2 The resistance of the casing at different values of the wind velocity in the tunnel is obtained from a calibrating curve made for that purpose

Four dash pots, M, two at each end of the oscillating axis of the balance, reduce the amplitude of the oscillations and make it more easy to weigh the thrust at H Four counterweights K adjustable along four vertical rods, are used for bringing the centre of gravity of the oscillating system in proximity to the axis of rotation XY, thus increasing the sensitiveness of the balance

Two men are needed to operate the balance—one for measuring the torque and the other for measuring the thrust. A third man regulates the speed in the wind tunnel by changing as required the speed of the fan supplying the air current, he has in front of him a Krell pneumometer on which he can read directly the velocity of the air in the experimental chamber of the tunnel. Each time that he reads the pneumometer the air velocity at which the experiment is to be performed he presses a button, a bell rings and the two men operating the balance try to equilibrate at the same time the oscillating structure J and to bring the swinging arm D to the zero position marked off on the drum N When after several trials this condition is obtained at the desired wind velocity in the tunnel the drum N is set rotating After the drum has made a complete rotation, the rotating mechanism is stopped again, and, on the recording card wrapped around the drum, the number of r p m. of shaft A at the moment when the balance was in equilibrium is found The number of r.p.m. measured on drum N, the weights measured at H and at L and the wind speed in the tunnel at the instant when these measurements were made, give all the elements for calculating the thrust and the torque of the model propeller under test.

All that is needed for working accurately and rapidly is to have three trained men, preferably always the same men, working together intelligently The three sections of the vertical shaft are made out of steel rods, the oscillating frame J is made out of steel tubes. Roller bearings are used at the motor shaft extension, and at the axis of rotation XY The maximum diameter of propellers used by the Italians in the experimental chamber of the tunnel, 2m in diameter, is 50 cm.

The St Cyr Balance—Fig 2 is a schematic view of the St Cyr balance A 50-h p D.C. variable speed motor 200/1,500 r p m , produces through the bevel gears B, C, G, the vertical shafts A, E, and the cardan D, a maximum speed of rotation of the propeller shaft H of 4,500 r p m.

On the propeller shaft, a torque dynamometer can measure directly the propeller torque which is also simultaneously measured at L, following the same general arrangement already described in connection with the Crocco balance

Fig. 3 gives detail views of the dynamometer, the transmission gears, and the propeller hub, and show how the motor torque is transmitted through the bevel gears G to an hollow shaft, which transmits the torque to the propeller shaft through a spring dynamometer The resisting torque of the

propeller is determined by the angle of torsion of the spring which is measured by a stroboscopic arrangement.

The torque transmitting mechanism and the oscillating arm E are enclosed in a casing fixed to the tunnel. Fig 4 shows the details of the airtight passage of the oscillating arm E through the wall of the tunnel. A set of calibrated springs will be used for the different speeds at which propellers will be tested.

The propeller thrust will be measured at K in the same way as it is measured on the Crocco balance, and in addition it is simultaneously measured on an hydraulic manometer M. The four counterweights N will be used for bringing the centre of gravity of the oscillating system in proximity to the axis of oscillation x y. Solid steel, shafts, steel tubes and roller bearings will be used in the construction of the balance.

Railroad Helium Repurification Plant

During the war one of the greatest military assets obtained by the Allies was the production of helium in quantities sufficiently great for use in balloons and airships While none actually reached the front, a supply was in transit and continuously increasing production assured. Helium is an element that occurs in only a few locations in quantities sufficient for extraction on a commercial scale The most promising fields thus far discovered are located in Texas, Kansas and Ohio It is believed by scientists that other sources of supply will be discovered susceptible of development for the production of helium in balloon quantities as the result of exploration work At the present time such an exploration program is being actively prosecuted by the Government

On account of the rare occurrence of this gas, of the high cost of production and the expense of transportation from point of production to point of use, a plant for its repurification after contamination through use in aircraft proved desirable The practice with hydrogen, when the purity of the gas becomes low, is to discharge the entire contents into the atmosphere, to use the entire contents for the inflation of free balloons, or to bleed part of the contents into the atmosphere, replacing the gas lost with fresh hydrogen thereby bringing the purity to the proper standard The daily loss of hydrogen from a 37,000 cu ft. balloon may run as high as 5000 cu ft. With a helium balloon attempt will be made not to lose more than a small fraction of this amount. The gas, instead of being allowed to escape into the atmosphere, will be bled from the envelope, and through a truck compressor unit compressed into cylinders under the standard pressure of 1800 lb per sq in. These cylinders will then be transported to a repurification unit where the impurities are extracted, the gas recompressed into cylinders and again used in the inflation of the envelope A production of 40,000 to 45,000 cu ft. of helium is expected within a period of three or four months and a great portion of this gas will be used at a distance of 800 to 1200 mi from the source of supply at Fort Worth, Texas A cylinder containing but 180 cu ft. of this gas weighs 135 lb

If attempt were made to ship helium, as it became impure, back to Fort Worth for repurification, the freight charges would amount to a very large figure, or if attempt were made to ship to zone repurification plants, the cost would be very heavy. It can be seen from the foregoing that the conditions surrounding the design of a repurification plant for helium point to the importance of a highly mobile unit. This was obtained by placing the plant on two standard 70-ton railroad cars

In actual warfare these units will be available for emplacement on the nearest railroad siding to the balloon and airship ascension points Several truck compressor units each with a capacity of 5000 cu ft per hour, will operate the balloon or airship beds, as the case may be, compressing the impure gas into cylinders which will be transported, at the earliest convenient time by trucks to the railroad repurification plant Here the cylinders of impure gas will be connected to manifolds discharging directly into the purifying column, passing out through another set of manifolds into cylinders being charged with purified gas.

This railroad repurification plant has a capacity of from 1000 to 2000 cu ft per hour and is designed to operate for 24 hours per day continuously, if need be, for a month or more at a stretch. The power to operate this plant is furnished by a 120-hp heavy duty gasoline motor directly connected to a direct-current generator However, where electrical current is obtainable, an alternating-current motor is used, which is also directly connected to the above mentioned generator, the engine being disconnected. The power plant is located in one car along with fuel supply tanks, sleeping quarters for the crew, office room, tool supply bins, etc. This power plant generates sufficient current to operate two repurification cars, one at each end, should larger capacity be required from a unit. The other car or repurifying car contains all the repurifying apparatus consisting of air and gas compressors (electrically operated), purifying column, manifolds, both charging and discharging, desiccators, cooling tower, fuel and water supply tanks, gasometer, testing apparatus, etc. This car is arranged to operate either from a platform or from the ground,—in one case the cylinders lying on their sides, in the other standing on end. The underframes of these cars are of standard U. S Steel construction built from plans of the U. S. Railroad Administration for the sake of standardization. The superstructure is of composite construction, with steel frame, wood and sheet steel sides, wood sheathing, etc., to secure warmth in cold weather, at the same time giving an exterior finish which conforms to the hydrogen gas car practice of the Air Service.

The truck compressor units are mounted on a 5-ton chassis. The compressors, of a compact vertical type of special design, the same as used in the repurification car, are connected through a gear reduction and flexible coupling to a 80 hp. heavy duty type gasoline motor Both compressor and engine are cooled through a single radiator suitably divided in order to allow the compressor to operate as cool as possible, at the same time giving the engine the required working temperature. The engine and compressor are mounted on a single sub base, the whole being housed in a composite wood and steel superstructure with sides opening out, giving working space to operate the manifolds, which are attached to the platform formed by the sides when open. Ample fuel and water supply tanks are provided for a continuous ten hour run. If difficulty is encountered in the operation of these units in rough and sandy country, a caterpillar tractor will have to be resorted to.

The principle upon which this repurification plant operates is simply stated, but rather complicated in application It consists of a liquefaction plant to reduce the temperature and change the pressure of the impure helium to a point where the impurity (air) is liquefied and drawn off, allowing the pure helium to escape in gas form This plant is at the present time under construction and every effort is being made to complete it in time to care for the helium production mentioned above.

Four New Air Routes Projected

The Post Office Department is contemplating an extension of its aerial mail routes and has requested an appropriation from Congress of $3,000,000

It is planned to link all the important cities from coast to coast and the new routes as outlined by the department are as follows

1 From Chicago to San Francisco. By this extension it will complete the route from the Atlantic to the Pacific Coast.

2. From Pittsburgh to Kansas City via Cincinnati, Indianapolis and St Louis.

3 From New York to Atlanta by an extension from Washington, D C

4. Minneapolis and St. Paul to St. Louis via Chicago

The new air routes would reduce by one-half the mail time by train between the named cities. For instance a letter mailed in New York would reach the Pacific Coast in approximately 45 hr and 15 min., west bound, against 90 hr and 30 min , west bound, by train, and 51 hr air time, east bound, against 102 hr., east bound by train time

The Post Office Department is also considering the establishment of a seaplane route down the Mississippi River from St Louis to New Orleans, stopping at Cairo, Illinois, Memphis, Tenn , and Vicksburg, Miss.

Effects of Wind Upon the Stability and Maneuverability of an Airplane in Flight

By Temple N. Joyce

Ever since the beginning of aviation the question as to whether wind has any effect on the stability and maneuverability of a plane has come up from time to time and has been argued both pro and con by experienced and inexperienced pilots. One group of flyers contend that the stability of a plane is affected when banking into or with the wind and that precautions must be taken in order to avoid a fatal fall, particularly when close to the ground. The other group assume that theoretically there might be a difference, but practically it is not observed. There are other views which are complications of the two former ones and in this article an endeavor will be made to explain all sides of this question, and in a manner prove that both theories are correct. It is hoped that the varied theories of the reader will coincide with at least one of these.

The argument that wind has no effect upon the stability of a plane can readily be supported by laws of physics and any attempt to prove by these laws that there is no effect will end in failure. That wind effects a plane's maneuverability can only be argued by taking into consideration certain psychological effects, which the average pilot neglects to do, namely, the difference between motion relative to earth and air. The fact that "bumps" disturb a plane's motion cannot be disputed, but this must not be confused with the above subject. The action of a plane under varying conditions can best be described with the aid of the accompanying diagrams and the paths of flight designated are those which would be made with reference to the ground.

Turning with the Wind

To proceed to the problem, Fig. 1, assume a condition where there is no wind and the pilot is traveling along the line AC in a northerly direction at a speed represented graphically by BC in a unit of time, and wishes to land along the line KM at M. Sub-consciously the pilot described a semi-circle on the ground below him, which will bring his plane up to the point K. To do this the pilot gives bank and rudder proportional to the degree of curvature he has assumed and the machine will swing around gracefully in the required amount of time ready to land at M.

Now consider a wind blowing in a northerly direction equal to the velocity of the plane and that velocity represented graphically by AB. The plane's velocity being BC the resultant action in the first unit of time at the beginning of the maneuver would be AC. With the same amount of bank and rudder as that used under conditions where there is no wind in the succeeding units of time the plane's position would be D', E', F', G', H', J' instead of E, F, G, H, K, L. The analysis of this is as follows.

In the second unit of time from C as rudder and bank are brought into play due to the plane's motion through the prevailing wind, it will have a westward component CX and a northerly component XD, with the velocity of the wind added the resulting position of the plane will be D'. In the next unit of time, due to the plane's given amount of bank and rudder, its westward component will be DX, which will have its effect not from D but from D' and its northerly component equal to XE plus the velocity of the wind will bring the plane into position of E'.

The reader can by a little study easily follow the successive stages of the plane's movement throughout the length of time necessary to turn 180 deg., facing into the wind at K' where it will have no velocity relative to the ground in any direction. The curve C'', D'', E'', F'', G'', H'', K'' represents the path of a plane when the wind velocity is one-half of its own.

One can see that the points at which the plane has no northerly or southerly motion on the various curves will pass from K' to G'' and finally F, according to the decrease in wind velocity. When there is a condition of no wind it will be observed that at F the plane is traveling over the earth in a direction the same as that in which the longitudinal axis is pointing. As wind comes into effect the motion of the plane at F'' and F', the corresponding points on the two wind curves will not be in line with the longitudinal axis but more or less sideways or diagonally from the longitudinal axis. The maximum effects are noticeable at F'' and F' and it is at these points when turning with the wind that a new pilot, who is a mechanical flyer, and who has not learned to fly by "feel," observing his plane passing over the ground sideways assumes that he is skidding and puts on more bank. This we all know is the correct thing to do for a skid, or else take out rudder to accomplish the same result, but as the plane was not skidding relative to the wind in which it was traveling, and in perfect stability, such a movement would cause a side slip and possibly a fatal accident if close to the ground. In a training plane where there is a small motor such a move would be distinctly noticeable, but types of planes that are used at the front with surplus of motor power, the effect will not be as great.

Turning Into the Wind

When turning against the wind, Fig. 2, a plane will seem to slip in instead of skid at the points mentioned above, namely, K'' and K', and the inexperienced pilot will make the mistake of adding an abnormal amount of rudder or decreasing the bank. The obvious result is a skid, which, if held long enough, will end in a stall and tail spin.

If the pilot simply desires to turn his plane about without any idea of bringing it over a definite spot, these effects will be less noticeable, but should he wish to land on a given spot, as illustrated, the controls will have to be handled differently to what they would be when there is no wind in order to make the same path over the ground. Pilots have often observed that at high altitude they never pay attention to the wind and one can see that this is due to the fact that the plane's motion over the earth is comparatively slow. A forty foot loss in altitude as a result of a side-slip at 5000 ft. is not half so noticeable as a twenty foot drop when flying at 100 ft.

Another point to remember about altitude flying is that movements are generally made with reference to the visible horizon or entire earth below and not a definite group of objects that would be distinguishable in a landscape from low altitude. It bears repeating that at low altitudes a pilot sub-consciously maps out his course on the ground with reference to definite objects, such as trees, patches of grass, tracks, etc., and it is the confusion of this mental-made path which he would execute if there were no wind with that which his plane actually executes when there is a wind. Experienced pilots, as a result of their sense of feel, actually take care of these necessary differences sub-consciously, but a student who tries to analyze every movement, in other words a "mechanical flyer," often finds it difficult to keep his plane under control. It is the confusion of this mental-made path of flight on the ground and the actual flight of the plane that causes accidents.

It is granted that the movement of a plane when turning into the wind is different from that when turning with it, also when there is no wind, and that the controls are operated differently under each condition. Its stability, however, is not effected in the least, only when the desired path of flight differs with the actual is it necessary to take caution.

These conditions are particularly noticeable when in a spiral. The object of a spiral being to lose altitude over a certain portion of ground and not gradually drift to one side or the other. It is necessary to give a different amount of bank and rudder when turning into the wind than with the wind in order to hold a position directly over the desired spot. This can be verified by observing the two curves designating a path when turning into and with the wind, and it is obvious that the controls will be handled differently in order to make a circle around a given point.

The conditions where the wind velocity equals the plane velocity was assumed in order to illustrate the maximum effect possible and not to explain how to fly when in such a wind.

The above explanation, it is hoped, will enable the reader to verify his own particular view-point on this much discussed problem.

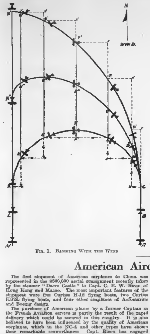


Fig. 1. Banking With the Wind

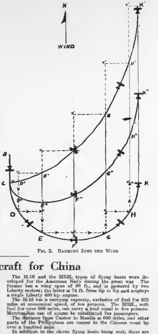


Fig. 2. Banking Into the Wind

American Aircraft for China

The first shipment of American airplanes to China was represented in the $500,000 aerial consignment recently taken by the steamer "Dacre Castle" to Capt. C. E. W. Ricou of Hong Kong and Macao. The most important features of the shipment were five Curtiss H-16 flying boats, two Curtiss HS2L flying boats, and four other seaplanes of Aeromarine and Boeing design.

The purchase of American planes by a former Captain in the French Aviation service is partly the result of the rapid delivery which could be secured in this country. It is also believed to have been influenced by the quality of American seaplanes, which in the NC-4 and other types have shown their remarkable seaworthiness. Capt. Ricou has engaged American pilots and mechanics—seventeen in all. All of these have served in the U. S. Navy or at Curtiss plants or flying fields. They will operate the American flying boats as merchandise and passenger carriers along the Chinese coast and between China and the Philippines.

The H-16 and the HS2L types of flying boats were developed for the American Navy during the great war. The former has a wing span of 96 ft., and is powered by two Liberty motors; the latter is 74 ft. from tip to tip and employs a single Liberty 400 hp. engine.

The H-16 has a carrying capacity, exclusive of fuel for 675 miles at economical speed, of ten persons. The HS2L, with fuel for over 500 miles, can carry a load equal to five persons. Merchandise can of course be substituted for passengers.

The distance from Canton to Manila is 600 miles, and other parts of the Philippines are nearer to the Chinese coast by over a hundred miles.

In addition to the eleven flying boats being sent, there are contained in the consignment sufficient aerfoils to re-equip ten of the eleven boats, ten complete extra motors, one hundred propellers (as extras), dope, glue, fabric, etc. Considerable auxiliary equipment such as trucks for handling the shipment, hangar and motor shop machinery and tools, etc., is included.

Some Recent German Airplanes

Our Danish correspondent has sent us in a fresh set of photographs of German machines all of which were exhibited at the Scandinavian Aero Show in Copenhagen.

Figs 1 and 2 illustrate the Kondor D. VI single seater fighter, in which a special effort has been made to secure vision upwards by splitting the upper plane of the biplane at the fuselage. This plane is equipped with a 200 hp. Goebel rotary engine, and apart from the above rather peculiar feature, the machine seems to be of very straightforward design, following standard German practice very closely.

The arrangement of the struts at the center of the machine seems to place them at a bad angle for taking the heavy compression of the upper spars. The arrangement of the cowling is rather curious. The row of air ducts fitted in the front is intended to supply air to the cylinder heads for cooling purposes, but the arrangement does not seem to be the best possible, aerodynamically.

The Daimler one-place pursuit machine illustrated in Fig 3 has a fuselage of excellent streamline and a neat cowling for the cylinder heads, with small louvres. The struts are rather peculiarly arranged, the rear strut having a backward inclination. It is interesting to note from the cowling that this machine is fitted with a V-type engine, which is probably the Mercedes 8-cyl. 240 hp model. This engine was produced some time in 1917 and was described at the time in Aviation and Aeronautical Engineering.

The triplane shown in Fig. 4 is a product of the Schutte-Lanz works, the well-known builders of rigid airships. This machine is chiefly notable for the peculiar trussing of the wings, struts replacing the usual cross-bracing wires. Here again the fine streamline of the fuselage is noteworthy, though not astonishing on the part of airship constructors. The use of side radiators, on the other hand, is a practice which has been discarded on most modern German airplanes.

In Figs 5 and 6 are shown the Kondor type E. III and E. IIIa respectively. These machines are of the truss wing, internally braced type, of parasol design, the wings being of metal construction internally. The Kondor E. III is fitted with 140 hp. Oberursel rotary and has a speed of 195 kilometres (121 m.p.h.) per hour, and a climb of 5,000 metres (16,400 ft.) in 16 min. The E. IIIa with the more powerful 200 hp. Goebel engine reaches a speed of 124 m.p.h. and climbs to 16,400 ft. in 11 min. Outside of the wing trussing these two machines offer few points of interest. On the E. IIIa the same peculiar engine cowling is employed as in the Kondor D. VI.

Fig 7 illustrates an Austrian Scout turned out by the Phönix works of Vienna. This machine is fitted with a 240 hp Hiero engine and carries the radiator above the top wing. The design of this machine is far from being as neat as that of corresponding German planes.

The single seater Aviatik (Fig 8), D. VI shows two features not often exhibited on German planes, namely a geared engine and a four-bladed propeller. Otherwise the design is along conventional lines.

In the two seater Aviatik C. VI illustrated in Fig 9 the designer has again made a desperate effort to improve the vision upwards by dividing the top plane and turning it down to the fuselage. The engine cowling fits in nicely into the veneer body. The outer pairs of Warren truss struts are brought on each to a point on the lower plane, and the forward wing strut meets the forward chassis strut at a fitting which permits of ready disassembly. In other respects the machine is a direct descendant of earlier Aviatiks.

The D. F. W. shown in Fig 10 does not possess very distinctive features. The spinner fairs nicely with the fuselage and is thus worth mentioning.

In Figs. 11 and 12 are illustrated interesting triplanes of the single-seater type. The Pfalz triplane of Fig 11 is a clean-looking product. The fuselage is a beautiful streamline, and the fin and wings are nicely rounded into the body. The lower wing evidently has only one spar, and while there is a double lift truss, the number of interplane struts has been reduced to minimum.

The Roland D. IV of the L. F. G. (Fig 12) is a very crude looking design, comparatively speaking, with engine exposed, the body choking both upper and lower wing, and an exposed trussing from the lower wing to the body. The center section struts are apparently joined together by a metal plate, so that cross wires are avoided just like in the well known Lepère strut system.

The Siemens-Schuckert biplane (Fig. 13) is fitted with four 260-hp. Mercedes engines distributed along the planes in a manner reminiscent of Sikorsky practice. It is very interesting to see that a successful machine can be built with the engines so arranged, although evidently this militates to some extent against manoeuvrability and also offers the danger of greater loss of control if one of the engines goes dead. While it is difficult to detect from the photograph what the construction of the undercarriage is like, it appears that there are rubber strands on either side of the two wheels, so that the axle is largely relieved of bending moments, which authorizes, if it does not vindicate, its inordinate length. While this arrangement of shock absorbers has been often considered in the design of twin-engined airplanes, there has always been a difficulty in connecting the struts on either side of the wheels. This is met in the present case by the use of the heavy steel forks which are clearly shown in Fig 13. With this heavy fork the chassis seems to be very well designed. While there is a totally enclosed cabin for the passengers, the pilot is apparently seated in the uncovered forward portion of the fuselage, whence he has a clear view of the ground.

Fig 14 illustrates an L. V. G. machine which affords an interesting example of large triplane design. The construction of the undercarriage is in particular noteworthy.

The peculiar looking biplane illustrated in Fig. 15 is a Gotha Grossflugzeug, that is, a giant airplane, in which the fuselage has been raised to the upper main plane. This gives splendid fighting possibilities and vision to the machine, and also permits the twin propellers to be placed much closer together. The streamlining of the engines is very neatly carried out. The mounting of the engines directly on the lower main planes makes the distance between the center of thrust and the center of resistance somewhat large, which has its obvious drawbacks, although this arrangement has undoubtedly the advantage of reducing head resistance by doing away with much strutting.

Fig 16 shows a Friedrichshafen biplane fitted with two 260-hp. Mercedes engines, which appears as a good combination fighting and bombing machine. The fuselage is very short, so that the nose is behind the propeller hub, thus allowing the propellers to be brought closely together with the advantages mentioned in the preceding paragraph. The whole machine has a simple and sturdy though not a very refined appearance.

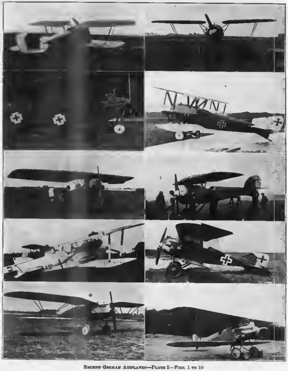
Vickers 4,800 Hp. Flying Boat

According to *Flugsport*, a gigantic seaplane is under construction at the Barrow works of Vickers, Ltd.

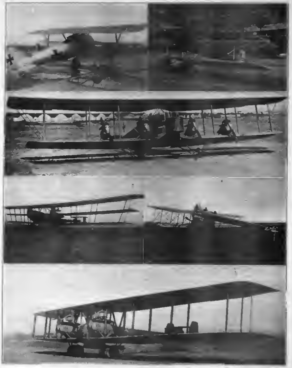
In its general outline the machine is a long hull flying boat, with overhanging biplane wings. Only approximate dimensions are available at this time, but the span is given as 300 ft., the overall length as 200 ft., the overall height as 42 ft. and the wing chord as 27 ft.

The power plant is fitted in four independent engine nacelles between the planes, each nacelle carrying two Rolls-Royce Condor 600 hp. engines "end on" and driving a tractor and a pusher screw, respectively. There are thus four tractors and four pushers, and the total horsepower is 4,800. It is estimated that the machine will be able to fly with full load on two-third engine power.

The framework of the boat and of the planes is entirely constructed of duralumin, while the planking of the hull is made of Consuta, a special plywood sewn with copper wire, which was developed by Messrs. Saunders, the well known yacht builders. The boat is fitted with two decks and is extensively furnished with passenger accommodations, there being sixteen two-berth cabins and a dining room in which in case of emergency thirteen more passengers can be accommodated. With forty-five passengers the cruising endurance of the flying boat is estimated at 1,400 sta. mi. The designed full speed is 110 m.p.h.



Recent German Airplanes—Plate I—Figs. 1 to 10



RECENT GERMAN AIRPLANES—PLATE II. FIGS. 11 TO 16

Aeromarine Eight Cylinder B Type Motor

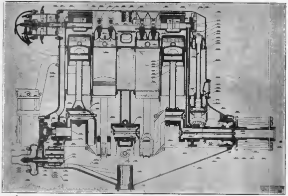
By W. C. Bauer, M.E.

This motor was primarily designed to include the greatest amount of power possible within the smallest possible overall dimensions; and, as will be noted of the installation diagram, the motor is almost unbelievably small for its horsepower capacity. The horsepower is rated at 150, obtained at 1,300 r.p.m. of the propeller, which is driven off on short shaft mounted above the crankshaft and geared four to seven with it.

In general, this type of motor, known as the B-6000 series, has eight cylinders, cast of iron in blocks of four and placed at an angle of 45 deg. with each other on an aluminum crankcase. The bore is 3⅝ in. and the stroke is 5⅛ in.

The cylinder blocks may be considered as a good example of the high development of the foundryman's art. The method used in casting with the entire water jacket portion of the block open, and screwing on covering plates, not only insures the lightest construction but eliminates the possibility of unevenness in thickness of cylinder walls and obstructions in the water passages. The cylinders are entirely surrounded by a generous water space, as are also the valve guides and valve pockets and spark plug bosses, thus insuring cool valve seats and stems, eliminating all trouble of burnt spark plugs and preignition due to incandescent metal and helping the vaporization of the fuel. A portion of the intake manifold passes directly through the water space of the cylinders. The valve seats, two intake and two exhaust for each cylinder, are machined directly into the cylinder castings. This type of cylinder construction finishes much lighter in weight than would ordinarily be expected, furnishes a cylinder of material that practice has proven to be best and by reason of its highly efficient cooling surfaces permits of a very high compression ratio without any of the high compression troubles.

The two overhead camshafts are encased in oil-tight housings, which also enclose the fulcrum and roller portions of the rocker arms. The camshafts are hollow, of one piece and large in diameter for their extremely short length, making a very light construction possible. The cams and valve action are a development of our own engineers and mark a distinct advancement in this direction as applied to aeronautical motors. Everything has been taken into consideration in the design of cams, valves and valve motion, with the result that now there is a perfect acting mechanism, which is not only able to produce the maximum power per unit of weight and cubical displacement, but also to reduce the tension of the valve springs and the weights of the actuating and actuated parts to a minimum.

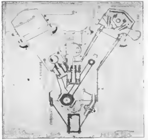


DIAGRAMMATIC CROSS-SECTION OF AEROMARINE B TYPE ENGINE, SIDE VIEW

The crankcase is of aluminum and is of two main parts, divided through the center of the crankshaft and clamping the main bearings. The engine supports are continuations of interior ribs of the crankcase and are surfaced by flanges and lugs to receive the bolts. A separate end housing contains the propeller shaft and the crankshaft overhang bearing.

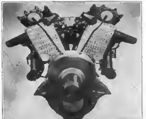
The dry sump system of lubrication is employed. Oil is drawn from both ends of the sump by a low pressure oil pump and forced out of the motor to an oil tank. The oil is cooled and filtered here and delivered to a high pressure pump, which feeds it through a suitable oil header to the main crankshaft

bearings and then into the hollow crankshaft, which in turn feeds the connecting rod bearings. The use of a dry sump system of lubrication permits of a much smaller crankcase besides making for a much more efficient system of lubrication. The crankshaft is of especially manufactured alloy steel, drop forged, heat treated and ground, and is the result of practical experience, derived through many years of actual flying. Large fillets are provided at all angles and the throws lightened by boring to lessen the centrifugal loading of the bearings. At the center, where this load is doubled, a large ball bearing has been employed with wonderful success.



Diagrammatic Cross-Section, End View

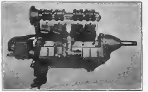
The connecting rods are of the articulated type, of tubular construction, carefully machined and balanced. The large end of the main rod clamps the babbitt-lined bronze bearing and the small end of the large rod, together with both ends of the smaller rod, have bronze bushings forced therein. The piston pins and large pins of the small rod are tapered inside at both ends for lightness and distribution of load.



Front View of Aeromarine B Type Motor

The hollow propeller shaft is driven by means of a 24-tooth pinion on the crankshaft, which meshes with a 42-tooth gear bolted on propeller shaft. The shaft runs on two tapered roller bearings placed opposite to each other at both ends for lightness and taking thrust in either direction and the radial loads.

Ignition is either by two special Dixie magnetos of the 800 type or by a Delco system. A generator is mounted in an



Side View of Aeromarine B Type Motor

upright position between the vertical shafts, regardless of the style of the ignition used.

The two carburetors are placed on opposite sides of the motor and a flange in line with the exhaust parts communicates through a passage way in the water jacket with the inner sides of the cylinder blocks. All manifolds are water-jacketed.

Specifications

No. of cylinders	8
Included angle	40 deg
Bore	6¾ in
Stroke	5½ in
Total volume	423 cu in
Compression ratio	6½ to 1
B.h.p. at 1800 r.p.m. propeller	180
B.h.p. at 1500 r.p.m. propeller	170
Brake m.e.p. at 1800 r.p.m.	121
Brake m.e.p. at 1500 r.p.m.	110
Piston speed	1800-2250 ft. per min.
Gear ratio	4 to 7
Total weight—dry motor complete with all accessories	420 lb
Weight per b.h.p.	2⅓ lb.
No. valves per cyl.	4
Dia. of all valves	1⅝ in.
Ratio valve area to piston area	1 to 3.44
Ratio valve area to piston displacement	1 to 18.76

Second N. Y. Aeronautical Show

New York's second annual Aeronautical Exposition, organized by the Manufacturers' Aircraft Association, will be held at the Seventy-first Regiment Armory, 34th Street and Park Avenue, from March 6 to 13, inclusive. This will be the first showing in New York of the great passenger and cargo carriers which have been developed since the war for commercial purposes. Besides these machines smaller sport and pleasure airplanes and airships and the latest developments in aircraft engines, accessories and flying equipment will also be exhibited.

"Estimating Performance of an Airplane"

In the article of this title, by Lieut.-Col. V. E. Clark, U. S. A., which appeared in the Nov. 15, 1919, issue of Aviation and Aeronautical Engineering, two printer's errors occurred on p. 350. Formula IV should read $W = C_lA = \ldots$ and Formula VII should read

$$T = \frac{(1 + C_r)(P + F + U)}{1 - [C_r/L(1 + C_r) + C_r]}$$

Factors Affecting the Warping of Plywood

By Armin Elmendorf

Engineer in Forest Products, U. S. Forest Products Laboratory

The warping of plywood panels is a matter of considerable concern to manufacturers who make panels for airplane use where large flat surfaces are desired. Experience and numerous tests made at the Forest Products Laboratory of the United States Forest Service, Madison, Wis., for the Army and Navy have shown that many factors may contribute to the distortion. It is the purpose of this discussion briefly to analyze some of the causes of warping and indicate several methods for minimizing it.

Methods of Measuring Warping

When a piece of plywood bends over as shown in Fig. 2, assuming the form of a cylindrical surface, it is said to "cup." The method of measuring cupping consists in placing a straight edge across the center of the panel so that it rests upon the upturned edges and the maximum recession of the panel from the straight edge is measured. If the distance between the edges is 10 in. and the recession 1 in., we say that the panel has cupped 1 in. in 10 in. A panel may, however, also be twisted as shown in Fig. 1, in which two edges that were parallel originally are now twisted relative to each other. The angle that the edge AA' in Fig. 1 makes with the surface upon which the panel rests is the angle of twist. Twisting is measured by placing the panel upon a smooth surface so that three corners are resting upon the surface, and then measuring the distance from the fourth corner to the surface. If, for example, an edge that is 10 in. long has twisted so that one corner is two inches above the surface, it would be said that the panel has twisted 2 in. in 10 in.

A panel that is twisted is usually also cupped, although panels that are cupped need not be twisted. In either case the panel is said to have warped.

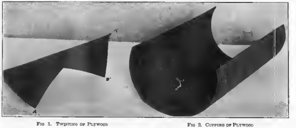


Fig 1. Twisting of Plywood

Fig 2. Cupping of Plywood

Relation of Moisture to Warping

One of the most pronounced results of a change in moisture content of an ordinary board is change in dimension, either as shrinkage or as expansion. Changes of moisture condition are responsible for almost all the undesirable distortions that occur in boards. For simplicity, only change of dimension which results from a reduction in moisture will be considered in this article.

The shrinkage of wood parallel to the grain is negligible compared to the shrinkage across the grain. On account of the great difference in shrinkage of wood in these two directions, a change in moisture content of plywood will inevitably either introduce or relieve internal stresses. As plywood consists of layers of wood glued together so that the grain of successive layers or plies cross, the shrinkage of one ply across the grain takes place at right angles to the across-the-grain shrinkage of the adjacent ply or plies.

We will consider a three-ply construction for an example and subject it to low humidity conditions so that the moisture content of the plywood is lowered. Since the grain of the core is at right angles to the grain of the faces, the core will tend to shrink a great deal more than the faces, in the direction of the grain of the faces. This shrinkage subjects the faces to compression (pressure) and the core to tension (pull). The magnitude of these internal forces depends upon the change in moisture content, the density, species, and the relative thickness of the core and face veneer.

The shrinkage of ordinary flat sawn boards in drying from the soaked or green to the oven-dry condition ranges from about 4 to 15 per cent, being greater for the heavy or high density woods than for the low density woods. A maple board 10 in. wide when changing moisture content from about 15 to 5 per cent may shrink 0.4 in. When in the form of a lamination between other laminations of wood whose grain crosses that of the first, it is obvious that maple wood in the center will be restrained from shrinking or, in other words, will be stretched across the grain almost the full 0.4 in. because there is little "give" in the outer laminations or plies parallel to the grain. The condition is analogous to that which would exist if an elastic sheet of a strong rubber were stretched and then glued between two plies of wood.

In order to minimize the distortions of plywood panels that are caused by changes in moisture content combined with inaccurate or faulty construction, it is imperative that all plies be at the same moisture content before gluing and that the moisture content of the finished panel on leaving the conditioning room be about the same as it will average when in use. The limits of from 10 to 15 per cent moisture in the finished panel will usually give satisfactory results when the panel is in service in the open air.

Symmetrical Construction of Plywood

Fig. 3 shows the distribution of the internal stresses in panels made of two, three, four and five plies.

An equal reduction in moisture content of all plies is

assumed to have taken place, causing the plies showing end grain in Fig. 3 to shrink in the direction indicated by the arrows. It is obvious that the 2-ply construction is going to cup so that the side b will be concave. In the 3-ply construction the ply c prevents the bending of the other two plies. When the plies a and c are of the same thickness, density, and species the pressures set up in each due to the pull of the center b will be approximately equal and the panel should not warp. On adding another ply d an additional pull

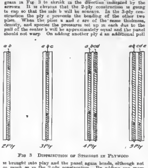


Fig. 3 Distribution of Stresses in Plywood

is brought into play and the panel again bends, although not so much as in the 2-ply panel. By adding one more ply e we have a 5-ply panel and it will be seen that the pressure in c should equal that in a and the pull in d should equal the pull in b. The stresses in the 3-ply and 5-ply panels are seen to be balanced and the panel should not warp if other conditions are satisfactory. Panels constructed in this way are said to be symmetrically built. A continuation of this discussion for larger numbers of plies leads to the generalization that in order to be symmetrical a panel must consist of an odd number of plies.

Panel No. 1 in Fig. 4 consists of two plies of 1/16 in. sugar maple and panel No. 2 in the same figure consists of four plies of the same species, successive plies crossing with the grain at right angles. The warping in each case is quite apparent.

In order to obtain a balanced construction it is also necessary that symmetrical plies (a and e in the 5-ply panel, Fig. 3 or a and c in the 3-ply panels of the same figure) be of the same thickness. If they are not of the same thickness the pressure or push exerted by the thinner ply will be less than the pressure of the opposite or symmetrical ply and the panel will tend to bow. Care in sanding a panel is therefore necessary to prevent non-uniform thicknesses. Cases of machine sanding are frequently seen in which thin face veneer is sanded through in spots. Panels having one-half the thickness of the face veneer ground away are quite common and, can of course, not be expected to remain very flat when subjected to moisture variations.

The use of different species of veneer for the symmetrical plies or veneer of different densities may also contribute to warping a panel. The differences in the magnitude of the shrinkage of different species for a given change in moisture content, and the differences in the stresses set up for the various species even for the same magnitude of shrinkage may cause considerable warping. The result of using maple veneer on one face of a 3-ply panel and basswood on the other is shown in Fig. 4, panel No. 3. The forces exerted by the maple in shrinking were greater than those exerted by the basswood so that this panel has cupped on the maple side.

Effect on Warping of Changing the Direction of the Grain of the Plies

In the discussion of symmetrical construction it was understood that the successive plies were always glued with the grain either parallel or exactly at right angles to the core. In careless construction this may not always be the case. In Fig. 4, for example, the face veneer of panel No. 4 is glued so that the grain of the face veneer makes 85 deg. with the grain of the core instead of the standard 90 deg. Considerable twisting was introduced. Panels No. 5 and 6 were glued with somewhat larger deviations in the direction of the grain of the face veneer and show more twisting.

An extreme case of this kind is shown in Fig. 1 in which the plies were glued so that the grain of each face of the panel was at 45 deg. with the grain of the core and the two faces at 90 deg. with respect to each other. From the illustrations given and from many observations, it appears that even quite small deviations from the standard 90-deg. construction may introduce twisting.

Relation of Density of Veneer to Warping

Numerous tests have shown that the warping of plywood panels when subjected to varying moisture contents is least for the panels made of low density veneer, and that in general warping increases with the density. This applies to panels in which all plies are of the same species.

Effect on Warping of Increasing the Ratio of the Core to the Total Plywood Thickness

Experience has shown that for 3-ply wood a high ratio of core to total plywood thickness contributes to maintaining a flat unwarped surface. In general, a ratio of from 0.5 to 0.7 will give satisfactory results where flatness is an important consideration.

Of two 3-ply panels having cores of the same weight one of low density veneer and the other of high density veneer,

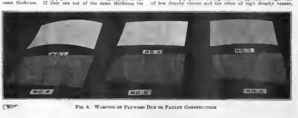


Fig. 4. Warping of Plywood Due to Faulty Construction

the panel having a low density core will in general show less warping than the panel having a high density core.

Summary

Wide deviations in the warping of panels seemingly built in the same way may occur because warping is often the result of a combination of influences some of which while not apparent may be the more important factors. The following points, if borne in mind while designing or manufacturing plywood, should aid in minimizing the tendency to warp.

1. One of the most important factors that must be controlled is the moisture content. The moisture content of the panel when it leaves the conditioning room should be about the same as it will average when in use, and all plies should be about the same moisture content before gluing. The limits of from 10 to 15 per cent moisture in the finished panel will usually give satisfactory results when the panel is in service in the open air.

2. Plywood panels should be made of an odd number of plies. For every ply of a given thickness and species at a certain distance from the core, there should be a corresponding ply on the opposite side of the core of the same thickness, density, and species and at the same distance from the core.

3. Even small deviations in the direction of the grain of successive plies may introduce considerable warping of a panel especially in the case of 3-ply constructions so that it is imperative that the grain of successive plies be at 90 deg. Considerable care should be exercised in trimming veneer and subsequently gluing it so that this rule be observed.

4. Plywood panels made of low density veneer are less inclined to warp than panels made of high density veneer.

5. In order to reduce warping of 3-ply panels, the use of a relatively thick core and thin faces is preferable to the use of plies that are all of the same thickness. A low density core is preferable to a high density core.

Book Reviews

Les Avions Allemands. By Jean Lagorgette. (E. Blondel de la Rougery, Paris. 214 pp., fully illustrated.)

M. Lagorgette has reproduced in book form the extremely interesting series of articles on German airplane construction which he published in *L'Aerophile* during the war. Full descriptions, with outline drawing and numerous sketches of constructional details, are given of practically every airplane and aircraft engine used by the Germans up to the armistice; several Zeppelins which were brought down in the Allied lines are also described and illustrated in detail.

Altogether this book may be considered as an excellent presentation of Germany's war effort in the air and as such it is just as valuable from the technical as from the historical viewpoint. M. Lagorgette is to be congratulated on his brilliant and painstaking work.

The Aerial Arm. By Lt. Col. N. J. Gill, with an introduction by Maj. Gen. Sir W. S. Brancker. (Aeroplane and General Publishing Co., London. 168 pp. Illustrated.)

This book occupies an intermediate position between a really technical work and the frankly popular type. It covers a good deal of ground, giving a good historical record of the development of both the airship and the airplane and is illustrated by a number of photographs. Besides, it has some interesting constructional sketches for the airplane, although these are of a more or less popular character.

The chapter on navigation of the air is particularly good and seems to be that branch of the subject in which the author is most interested. Two chapters deal with the military use of the airplane, and cooperation afloat, and here Colonel Gill exhibits a very sound knowledge of the military and naval uses of aircraft. Altogether it is an interesting little book.

The Design of Model Airplanes. By F. J. Camm. (Benn Brothers, Ltd., London. 168 pp. Many diagrams.)

The book is the result of a series of articles by Mr. Camm in *The Aeroplane*. It is extremely well written and complete and covers every type of model airplane which the amateur is likely to build. At the same time the book is evidently written by a man who understands the airplane as a machine and not as a model. This has a direct bearing on all the material written, that is to say, the models are never ridiculous from the point of view of aerodynamics.

The educational remarks on the theory of the airplane are always simple and well written. Some very interesting remarks are given on the making of model airscrews.

Report No. 67, National Advisory Committee for Aeronautics. Supplies and Production of Aircraft Woods.

The purpose of this report is to present in brief form such information as is available regarding the supplies of the kinds of wood that have been used or seem likely to become important in the construction of airplanes, and the amount of lumber of each species normally put on the market each year. A general statement is given of the uses of which each kind of wood is or may be put, but no attempt has been made to go into a technical discussion of these various uses.

The information contained in this report has been compiled from a great many sources, including principally published and unpublished reports by various members of the Forest Service. Many of the figures given, particularly those relating to amounts of standing timber, are only crude estimates, but until we have a census of the forest resources of the country we shall have to depend largely on guesswork. The figures on production of lumber are taken from the annual lumber census reports and may be relied upon. Estimates as to the proportions of the total lumber production of different species that may be suitable for the manufacture of aircraft are necessarily very general, and are open to modification as methods of sawing or as airplane specifications change.

It is believed that all the species used to any extent or approved for use in American aircraft are included. However, specifications in all probability will be changed as the industry develops. Consequently, the use of many kinds of woods not now considered suitable may eventually be allowed.

Statements regarding the uses of the different woods are included in order to give an idea of the industries with which aircraft manufacturers will have to compete for their lumber supplies. The figures published were obtained several years ago and hence may not exactly represent present conditions, since the annual production of lumber of many of the species has changed considerably in the interval.

The maps that accompany this report show by dots the approximate locations of the mills that in 1917 produced the largest amounts of the lumber of most of the species covered. These maps, therefore, indicate in a general way the sources of commercial supplies of the various species.

A copy of this report may be obtained upon request from the National Advisory Committee for Aeronautics, Washington, D. C.

Joint Army and Navy Board on Aeronautics

The Secretary of War and the Secretary of Navy have agreed to change the name of the Joint Army and Navy Board on Aeronautics to Aeronautical Board and all communications, etc., to be forwarded to this Board will be addressed as above.

The present members of the Board are: Maj. Gen. Chas. T. Menoher, Director of Air Service, Chairman; Lieut. Col. George A. Nugent, C. A. C. U. S. A.; Lieut. Col. Byron Q. Jones, A. S. A. S. A.; Capt. Thomas T. Craven, U. S. N., Director of Naval Aviation; Capt. Lyman A. Hulton, U. S. N.; Comdr. J. C. Hunsaker, U. S. N.; Comdr. Warren G. Child, U. S. N., and Lieut. Col. A. R. Christie, A. S., A. S. A. Working Committee, and Capt. A. J. Clayton, A. S., A. S. A., Secretary.

The duties of this Board are to consider and make recommendations for prevention of duplication, to secure coordination in the plans for new projects for construction of aircraft, for experimental stations, coastal air stations and for stations to be used jointly by the Army and Navy; as well as questions relating to the development of new types of aircraft and weapons used on aircraft, and other important questions relating to Government activities.

The Zeppelin Giant Sea Monoplane

THREE-QUARTER FRONT VIEW OF THE ZEPPELIN GIANT SEA MONOPLANE
Photo International

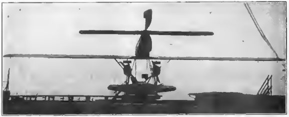
The accompanying photographs illustrate one of the most unusual seaplanes ever built, the Zeppelin giant sea monoplane. This machine was under construction for the German Navy when the armistice was signed and will soon be turned over to the Inter-Allied Aeronautical Commission, which has been investigating German aircraft activities.

The Zeppelin giant seaplane is entirely built of duralumin and has a wing span of 120 ft., which makes it the largest monoplane in the world, its span being but 6 ft. shorter than that of the NC boats. In a sense this machine is a flying boat, inasmuch as the floating portion accommodates part of the crew, but as there is beside the boat hull also a separate fuselage, which carries the remainder of the crew, the machine may just as well be described as a center float seaplane. This is a striking example of the difficulty of drawing in some cases a distinct line between float and boat type seaplanes.

The power plant is composed of four 260 hp. 6-cyl. Mercedes engines, which are disposed in two nacelles arranged between the boat hull and the fuselage and drive tractor and pusher screws, respectively. The maximum speed is 90 m.p.h. and the fuel supply allows a continuous flight of 10 hr.

Two pilots are seated in the bows of the boat, which accommodates besides a gunner, while another gunner's nest is situated on the stern. Between the pilot cockpit and the after gunner's nest are placed the fuel and oil tanks and seats for two engineers. The fuselage, which carries the tail planes, is provided in the nose with an enclosed cabin, which houses the remainder of the crew. Here are situated a wireless room and two more gun-nests. The crew totals nine men, made up as follows: Two pilots, two engineers, one wireless operator and four gunners. Access is had from the boat to the fuselage by means of scaling ladder.

The military characteristics of the Zeppelin giant seaplane are extremely interesting, because the emplacement of the guns is such that there does not seem to be any dead angle to them. The fuselage guns are able to sweep the whole upper flight hemisphere, while the boat guns can almost do likewise with respect to the lower hemisphere. The seaplane is thus very well protected against enemy attacks, although, of course, the sluggishness inherent to all large machines would easily cause it to be outmaneuvered by an opponent flying a one-place pursuit seaplane.



REAR VIEW OF THE ZEPPELIN GIANT SEAPLANE—NOTE SHAPE OF HULL
Photo International

Above—Four Seater Biplane Type "F"
Below—Single Seater Pursuit Scout Type "D"

AIRCRAFT DEPARTMENT
ORDNANCE ENGINEERING CORPORATION
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Above—Primary Training Aeroplane Type "A"
Below — Single Seater Pursuit Fighter Type "B"

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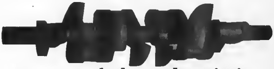

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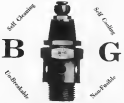

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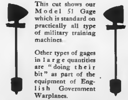

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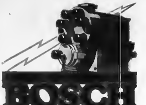

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Aeronautical Engineering and Airplane Design

By *LIEUTENANT ALEXANDER KLEMIN*

Air Service, Aircraft Production, U. S. A. in Charge Aeronautical Research Department, Airplane Engineering Department. Until entering military service in the Department of Aeronautics, Massachusetts Institute of Technology and Technical Editor of Aviation and Aeronautical Engineering. In two parts.

Part 1. Aerodynamical Theory and Data

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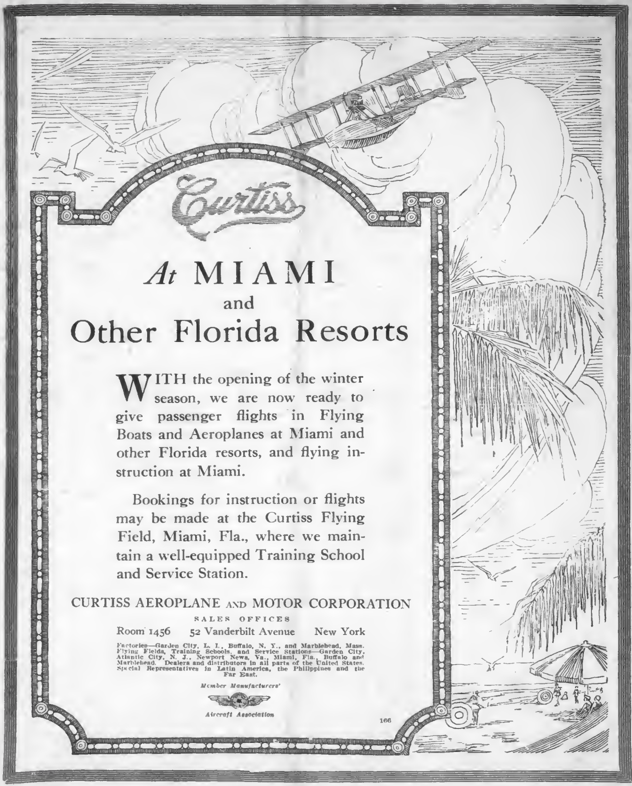
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